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Comparison of Indirect MR Arthrography With Conventional MRI in the Diagnosis of Knee Pathologies in Patients With Knee Pain

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Abstract

Background: Knee pain is a common problem in the general population. In order to determine the extent of the injury and the appropriate treatment, MRI provides the most accurate imaging method. This may be done through conventional MRI techniques or by injecting a contrast material (MR arthrography).
Objectives: The purpose of this study was to compare the diagnostic value of these two methods.
Patients and Methods: The study involved the diagnostic evaluation on 60 patients with knee pain who received treatment over the course of a one-year period. Referred patients were randomly divided into two groups: indirect MR arthrography was performed on one group, and conventional MRI was performed on the other group. Both groups then underwent arthroscopy. The results from both groups were compared with the arthroscopic findings.
Results: In all of the pathologies studied, the sensitivity, specificity, and the positive and negative predictive values were evaluated. A high rate of accuracy was found between MR arthrography and arthroscopy ($P < 0.05$) for all knee injuries, however a similar rate of accuracy between conventional MRI and arthroscopy was only seen in patients with damage to the posterior cruciate ligament (PCL), the tibio-femoral articular cartilage, and patella chondromalacia ($P < 0.05$). The highest rate of accuracy was seen in cases where indirect MR arthrography was used for the diagnosis of anterior cruciate ligament (ACL) damage ($K = 1$).
Conclusions: Our results have shown that indirect MR arthrography had greater diagnostic accuracy in regards to the sensitivity, specificity, and positive and negative predictive values than conventional MRI in knee pathologies.

Keywords: Indirect MR Arthrography, Conventional MRI, Knee Pain

1. Background

Sports injuries caused by traumatic and non-traumatic events, including meniscus and ligaments tears, are the most common cause of knee problems in adults and often result in bone structure or intra-articular damages (1). Many meniscal and ligament injuries can be diagnosed using a combination of historical analysis and physical examination. However, for a definitive diagnosis and appropriate guidance for the choice of therapy, imaging of the meniscus is required. Different types of imaging, including an X-ray and a CT scan, can be used for knee assessment, but magnetic resonance imaging (MRI) is currently the most accurate means of achieving this goal (2, 3).

There are two methods of performing magnetic resonance imaging of the knee: 1) by injecting contrast material (either intravenously or intra-articular), or 2) conventional MRI without injection (2, 3). When compared with conventional non-injected MRI, MRI with intra-articular injection is more sensitive in detecting knee pathologies. Unfortunately, this method is invasive and painful. Furthermore, due to the use of fluoroscopy to guide the physician, greater expertise is required and the patient is exposed to radiation. There may also be side effects such as infection, bleeding, and joint swelling (4). However, indirect MR arthrography (with an IV contrast) avoids the side effects of intra-articular injections and has greater tolerance by patients due to less pain (5, 6).

Several studies have explored the implications of using MR arthrography. One study has revealed that MR arthrography was more accurate when diagnosing recurrent or residual meniscal tears in cases of patients with more than 25% meniscus removal or who had no appropriate joint effusion (7). Another study has shown that direct or indirect MR arthrography improves the diagnostic accuracy of meniscal tears in comparison with conven-

tional MRI (8). While a majority of the previous studies have compared the accuracy of direct MR arthrography, an invasive method, with conventional MRI in the diagnosis of knee pathologies, few studies have reviewed the diagnostic value of indirect MR arthrography, a minimally invasive procedure, in comparison with conventional MRI.

2. Objectives

The aim of our study was to compare the diagnostic value of the minimally invasive indirect MR arthrography with conventional MRI techniques in the diagnosis of knee pathologies. We believe that if this non-invasive method has high diagnostic accuracy when compared with conventional MRI, it can be used as a valuable and safe modality in patients with knee pain, reducing the requirement of diagnostic arthroscopy and lowering medical costs.

3. Patients and Methods

The research presented here is in the form of a double blind clinical trial study that was conducted on 60 patients with knee pain who were referred for treatment to the orthopedic clinic at Poursina Hospital. All patients with knee pain who were candidates for further evaluation with MRI after historical analysis and examination by an orthopedist were enrolled in the study. Patients with a history of knee surgery and patients who did not have the opportunity for follow-up examinations were excluded from this study. We excluded patients with positive surgical history because previous surgery at the site of damage can affect the MRI results, thus leading to a potentially biased interpretation. This study was part of a thesis for Gilan University of Medical Sciences and received ethics committee approval (registration No. 707). Consent to participate in the study was obtained from all of the patients.

Patients were randomly assigned to two groups: group 1 received conventional MRI and indirect MR arthrography was performed on group 2. For indirect MR arthrography, 0.1 mmol/kg of intravenous gadolinium was injected. To ensure uniform distribution in the joint cavity and thus to facilitate the evaluation of the components of the joint, each joint was exercised for 5 - 10 minutes. Patients were then placed in the supine position with the knee in a fully extend position, and an MRI of the knee was then obtained. The MRI procedures were all conducted in one center with 1.5 Tesla qualities. The interpretation of all MRI results was performed by a radiologist outside of the project and then reviewed by a contributing orthopedic surgeon. Patients who were selected to undergo arthroscopy were referred to a second orthopedist who was unaware of the MRI results. Finally, the results and variables obtained from both groups (indirect and conventional MRI) were compared with the arthroscopic findings as a "gold standard" test. Damage to the lateral meniscus (LM), the medial meniscus (MM), the anterior cruciate ligament (ACL), the posterior cruciate ligament (PCL), the tibio-femoral articular cartilage, and patella chondromalacia were assessed for all patients in the study.

The data were analyzed using SPSS software, version 16. To compare the diagnostic value of indirect MR arthrography with conventional MRI, the parameters of sensitivity, specificity, positive predictive value and negative predictive value were used. In determining the extent of agreement with both MRI and arthroscopy, the kappa coefficient was used. A chi-square test was used to compare the two-way accuracy. A significant P value was defined as less than 0.05, and tests were evaluated bilaterally. The difference between the tests was also examined statistically.

4. Results

Data on 60 patients (40 males [66.7%] and 20 females [33.7%]) with an average age of 34 ± 1.25 years was collected for this study. Twenty-two men and 8 women received MR arthrography, and conventional MRI was performed on the remaining 30 patients. There was a significant relationship between the accuracy of indirect MR arthrography and arthroscopy in all six possible pathological diagnoses (Table 1). With conventional MRI and arthroscopy, a significant degree of accuracy was observed only in the diagnosis of PCL injuries (P = 0.02), tibio-femoral articular cartilage damage (P = 0.03), and patella chondromalacia (P = 0.001).

There was no agreement between conventional MRI and arthroscopy with respect to revealing damage to the lateral meniscus (K = -0.015), the medial meniscus (K = -0.056), or the anterior cruciate ligament (K = -0.309). Posterior cruciate ligament injuries and tibio-femoral articular cartilage damage had poor agreement in terms of conventional MRI and arthroscopy (K = 0.423 and K = 0.25 respectively), while a high level of agreement was found regarding patella chondromalacia (K = 0.535).

There was also no agreement between conventional MRI and indirect MR arthrography in the diagnosis of damage to the medial meniscus (K = -0.1), the lateral meniscus (K = -0.033), the anterior cruciate ligament (K = -0.1), the posterior cruciate ligament (K = -0.067), the tibio-femoral articular cartilage (K = -0.233) or patella chondromalacia (K = -1).

Sensitivity, specificity, positive predictive value, and negative predictive value of conventional MRI techniques and indirect MR arthrography for the diagnosis of these six pathologies are listed in Table 2.

Table 1. Findings Related to Joint Pathology From Conventional MRI and Indirect MR Arthrography in Comparison With Results Obtained From Knee Arthroscopy

Arthroscopy	Conventional MRI					Indirect MR Arthrography				
	Yes	No	Total	P	K	Yes	No	Total	P	K
LM damage				0.398	-0.015				0.001	0.59
Yes	2	8	10			6	1	7		
No	7	13	20			4	19	23		
Total	9	21	30			10	20	30		
MM damage				0.626	-0.056				0.006	0.85
Yes	14	13	27			18	1	19		
No	2	1	3			1	10	11		
Total	16	14	30			19	11	30		
ACL damage				0.088	-0.309				0.001	0.93
Yes	7	6	13			13	0	13		
No	4	13	17			1	16	17		
Total	11	19	30			14	16	30		
PCL damage				0.02	0.423				0.001	0.762
Yes	2	2	4			4	0	4		
No	2	24	26			2	24	26		
Total	4	26	30			6	24	30		
Tibio-femoral articular cartilage damage				0.03	0.25				0.001	0.831
Yes	2	8	10			7	0	7		
No	0	20	20			2	21	23		
Total	2	28	30			9	21	30		
Patella chondromalacia				0.001	0.535				0.001	1
Yes	3	4	7			6	0	6		
No	0	23	23			0	24	24		
Total	3	27	30			6	24	30		

5. Discussion

The results of our study showed that indirect MR arthrography was more accurate and helpful in the diagnosis of meniscal lesions than using conventional MRI procedures. Mathieu et al. have obtained a similar result in their research. They have also shown that MR arthrography was more effective than conventional MRI procedures in evaluating meniscal lesions. In their study, sensitivity and specificity of indirect MR arthrography were 100% and 89.6%, respectively, while conventional MRI produced results of 92.3% and 82.8% accuracy, respectively. When compared with arthroscopy, the degree of agreement for conventional MRI was K = 0.69, and K = 0.84 for indirect MR arthrography (9). In our study, this rate of agreement with arthroscopy for indirect MR arthrography was 0.72, and for conventional MRI, it was 0.035. In a study by White and his colleagues who examined meniscal tears, the diagnostic accuracy for indirect MR arthrography was higher than that of conventional MRI; indirect MR arthrography produced accuracy ratings of 90% for sensitivity, 78% for specificity, 90% for positive predictive value, and 78% for negative predictive value. In this same study, conventional MRI had accuracy ratings of 86% for sensitivity, 67% for specificity, 83% for positive predictive value and 71% for negative predictive value. Their study reveals that greater accuracy is obtained with indirect MR arthrography than with conventional MRI (10). Other studies have shown an accuracy rate of up to 89 - 98% for sensitivity and 88 - 95% for reliability with indirect MR arthrography (11, 12).

In our study, the statistical results of indirect MR arthrography were significantly in agreement with the results of arthroscopy (P = 0.001 for the lateral meniscus and P = 0.006 for the medial meniscus). This degree of agreement did not exist with conventional MRI (P = 0.398 for the lateral meniscus and P = 0.626 for the medial meniscus). In another study that was performed on recurrent meniscal tears on 72 patients, the sensitivity, specificity, and accuracy with arthroscopy and conventional MRI was reported as 4%, 75%, and 57.7%, respectively; indirect MR arthrography was reported as having an accuracy rate of 94.5%, 87.5%, and 93.4% respectively (7). This study agreed with our own findings that there was a higher degree of accuracy with indirect MR arthrography than with conventional MRI when compared with the results of arthroscopy.

In Harman and colleagues' study conducted on 42 patients, sensitivity, specificity, and accuracy for indirect MR arthrography was reported at 100% each, but these indica-

Table 2. Statistical Indicators Related to Indirect MRI Arthrography and Conventional MRI Tests for the Diagnosis of Knee Pathology[a]

Pathology/Test	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
LM damage				
Conventional MRI	2 (20)	13 (65)	2 (22.2)	13 (61.9)
Indirect MR arthrography	6 (85.7)	19 (82.6)	6 (60)	19 (95)
MM damage				
Conventional MRI	14 (51.9)	1 (33.3)	14 (87.5)	1 (7.1)
Indirect MR arthrography	18 (94.7)	10 (90.9)	18 (94.7)	10 (90.9)
ACL damage				
Conventional MRI	7 (53.8)	13 (76.5)	7 (63.6)	13 (68.4)
Indirect MR arthrography	13 (100)	16 (94.1)	13 (92.9)	16 (100)
PCL damage				
Conventional MRI	2 (100)	24 (92.3)	2 (50)	24 (100)
Indirect MR arthrography	4 (100)	24 (92.3)	4 (66.7)	24 (100)
Tibio-femoral articular cartilage damage				
Conventional MRI	2 (20)	20 (100)	2 (100)	20 (71.4)
Indirect MR arthrography	7 (100)	21 (91.3)	7 (77.8)	21 (100)
Patella chondromalacia				
Conventional MRI	3 (42.9)	23 (100)	3 (100)	23 (85.3)
Indirect MR arthrography	6 (100)	24 (100)	6 (100)	24 (100)

[a]Values are expressed as No. (%).

tions for conventional MRI were 87%, 100%, and 98%, respectively (13). The results of this study, as in our study, confirm that despite the usefulness of both methods in diagnosing patella chondromalacia, indirect MR arthrography is superior to conventional MRI procedures.

Our results, as well as the results of other studies, show that indirect MR arthrography has greater diagnostic accuracy, sensitivity, specificity, and positive and negative predictive values than conventional MRI procedures, and may also be used as an alternative to conventional MRI for the detection of knee lesions. It should also be noted that indirect MR arthrography has a lower level of required expertise and experience when compared with the direct injection required for direct MRL arthrography. Furthermore, indirect MR arthrography avoids many of the complications observed in intra-articular (direct) injection, such as pain, infection, bleeding, and swelling.

A final note must be made regarding tibio-femoral articular cartilage and posterior cruciate ligament injuries. There have been relatively few studies, and only with small test groups, on these conditions. While we conclude that indirect MR arthrography can be used as a suitable substitute method for arthroscopy in knee pathologies, we recommend further investigation regarding the accuracy of indirect MR arthrography for diagnosis of these two conditions.

Footnote

Authors' Contribution: Ali Babaei-Jandaghi: interpreting MRI results; Mohsen Mardani-Kivi: performing arthrography; Ahmadreza Mirbolook: collecting and referring patients; Mohammad-Kazem Emami-Meybodi: scientific and statistical consulting; Solmaz Mohammadzadeh: performing MRI; Maral Farahmand: writing manuscript.

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